Program listing

```
10 REM ************************************************************
20 REM *   IEEE METHOD - TRANSIENT OR STEADY STATE CALCULATION
30 REM *  OF BARE OVERHEAD CONDUCTOR TEMPERATURE OR THERMAL RATING
40 REM *
50 REM *
60 REM *
70 REM *    ASSUMES SI UNITS FOR INPUT
80 REM *
90 REM *
240 REM * IN COMPARISON WITH THE 1986 VERSION OF THIS PROGRAM, PROVIDED
250 REM * BY THE IEEE, THE 1993 VERSION ADDED THE FOLLOWING FEATURES:
260 REM *
290 REM *  - INITIAL CONDUCTOR TEMP OR CURRENT CAN BE USED IN
300 REM *    TRANSIENT CALCULATIONS
330 REM *  - VERY SHORT DURATION "FAULT" CURRENTS AS LARGE AS 1E6
340 REM *    AMPERES FOR TIMES AS SHORT AS 0.01 SEC CAN BE USED
350 REM *  - THE ORIGINAL NUMERICAL ITERATION METHOD HAS BEEN
360 REM *    REPLACED WITH A MUCH MORE EFFICIENT METHOD
370 REM *  - FOR ACSR CONDUCTOR, THE HEAT CAPACITY OF THE STEEL CORE
380 REM *    AND THE OUTER ALUM STRANDS ARE ENTERED SEPARATELY.
390 REM *
392 REM *   THIS VERSION IS CONSISTENT WITH IEEE 738-2012
394 REM *  - THE SOLAR MODEL ALLOWS ANY HOUR AND LATITUDE
396 REM *  - THE AIR PROPERTIES ARE CALCULATED WITH CLOSED FORM EQUATIONS
398 REM *  - THIS PROGRAM AND EQUATIONS USE SI UNITS
400 REM ************************************************************
410 REM ***********************************
420 REM * INITIALIZE VARIABLES AND ARRAYS *
430 REM ***********************************
440 DIM ATCDR(1000)
450 DIM TIME(1000)
460 FLAG1 = 0
470 XIDUMMY = 0
480 XIPRELOAD = 0
490 XISTEP = 0
500 TCDR = 0
510 TCDRPRELOAD = 0
520 TCDRMAX = 0
530 IORTPRELOAD = 0
540 DELTIME = 0
550 FS1 = 0
560 FS2 = 0
570 FS3 = 0
580 X$ = STRING$(56, 45)
590 REM *******************************
600 REM * START REPEAT CALCULATION HERE
610 REM *******************************
620 FOR KI = 1 TO 1000
630 ATCDR(KI) = 0
640 TIME(KI) = 0
650 NEXT KI
660 NFLAG = 0
670 PI = 3.141593
672 PIANG = PI / 180!
680 IF FLAG1 = 99 GOTO 1120
690 REM ***********************************************
700 REM * SPECIFY DATA INPUT ASCII FILE NAME
710 REM ***********************************************
720 CLS
730 INPUT "ENTER INPUT FILE NAME ", F$: OPEN F$ FOR INPUT AS #1
850 REM ************************************************************
860 REM * ENTER DATA FROM INPUT FILE
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870 REM ************************************************************
880 GOSUB 8000
1120 REM ***************************************
1130 REM * CALCULATE SOLAR HEAT INPUT TO CONDUCTOR
1140 REM ***************************************
1150 GOSUB 5000
1160 REM ************************************************************
1170 REM * CALCULATE THERMAL COEF OF RESISTANCE & WIND ANGLE CORRECTION
1180 REM ************************************************************
1190 GOSUB 9000
1200 REM *********************************
1210 REM * SELECT THE CALCULATION DESIRED
1220 REM *********************************
1230 ON NSELECT GOTO 1500, 1240, 1460, 1460
1240 REM ************************************************************************
1250 REM *          FOR NSELECT = 2
1260 REM * GO TO AMPACITY SUBROUTINE TO CALCULATE THE STEADY STATE
1270 REM * CURRENT (TR) GIVEN THE STEADY STATE CONDUCTOR TEMPERATURE (TCDR)
1280 REM * THE CONDUCTOR TEMPERATURE IS GIVEN SO ONLY ONE PASS THROUGH
1290 REM * THE SUBROUTINE IS REQUIRED.
1300 REM ************************************************************************
1310 TCDR = TCDRPRELOAD
1320 GOSUB 15000
1330 REM ******************************
1340 REM ************************************************************************
1350 REM
1360 REM ************************************************************************
1370 REM *          FOR NSELECT = 1,3,OR 4
1380 REM * GO TO AMPACITY SUBROUTINE REPEATEDLY IN ORDER TO CALCULATE
1390 REM * THE STEADY STATE CURRENT (TR) CORRESPONDING TO TRIAL VALUES OF
1400 REM * CONDUCTOR TEMPERATURE (TCDR). IF T=1 THEN THE OUTPUT OF THE
1410 REM * SUBROUTINE, TR, IS THE STEADY STATE CURRENT FOR
1420 REM * WHICH A STEADY STATE TEMPERATURE WAS TO BE FOUND.
1430 REM * IF T=3 OR 4 AND IORTPRELOAD=1, THEN TR IS THE INITIAL PRE-STEP
1440 REM * CHANGE CURRENT FOR WHICH AN INITIAL TEMPERATURE WAS TO BE
CALCULATED.
1450 REM ************************************************************************
1460 ON IORTPRELOAD GOTO 1500, 1650
1470 REM *******************************************
1480 REM * CALCULATE TCDR GIVEN XIDUMMY = XIPRELOAD *
1490 REM *******************************************
1500 XIDUMMY = XIPRELOAD
1510 NFLAG = 0
1520 GOSUB 13000
1530 TCDRPRELOAD = TCDR
1540 REM ************************************************************
1550 REM * FOR NSELECT = 1 THE PROGRAM HAS FOUND THE STEADY STATE CONDUCTOR
1560 REM * TEMPERATURE (TCDRPRELOAD) CORRESPONDING TO THE GIVEN STEADY STATE
1570 REM * CURRENT (XIPRELOAD)
1580 REM ************************************************************
1590 IF NSELECT = 1 THEN 1730
1600 REM ************************************************************
1610 REM * FOR NSELECT = 3 OR 4, THE PROGRAM HAS DETERMINED (IORTPRELOAD=1) OR
BEEN
1620 REM * GIVEN (IORTPRELOAD=2) THE INITIAL STEADY STATE CONDUCTOR TEMPERATURE
1630 REM * AND CONTROL PASSES TO FURTHER TRANSIENT CALCULATIONS
1640 REM ************************************************************
1650 IF NSELECT = 4 THEN GOSUB 10000
1660 REM ************************************************************
1670 REM * BEGIN CALCULATION OF CONDUCTOR TEMP AS A FUNCTION OF TIME
1680 REM * FOR A STEP INCREASE IN ELECTRICAL CURRENT, NSELECT = 3
1690 REM ************************************************************
1700 ET = 3600!
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```
1710 XISTEP = XISTEP
1720 GOSUB 11000
5000 REM ////////////////////////////////////////////////////////
5010 REM / SUBROUTINE TO CALCULATE CONDUCTOR SOLAR HEAT GAIN (QS)
5020 REM ////////////////////////////////////////////////////////
5030 IF SUN.TIME >= 24 THEN 5560
5040 DEG.TO.RAD = PI / 180!
5050 CDR.LAT.RAD = CDR.LAT.DEG * DEG.TO.RAD
5060 REM * SOLAR DECLINATION
5070 DECL.DEG = 23.4583 * SIN(((284 + NDAY) / 365) * 2 * PI)
5080 DECL.RAD = DECL.DEG * DEG.TO.RAD
5090 REM * SOLAR ANGLE RELATIVE TO NOON
5100 HOUR.ANG.DEG = (SUN.TIME - 12) * 15
5110 HOUR.ANG.RAD = HOUR.ANG.DEG * DEG.TO.RAD
5120 REM * FIND SOLAR ALTITUDE - H3
5130 H3ARG = COS(CDR.LAT.RAD) * COS(DECL.RAD) * COS(HOUR.ANG.RAD) +
SIN(CDR.LAT.RAD) * SIN(DECL.RAD)
5140 H3.RAD = ATN(H3ARG / SQR(1 - H3ARG ^ 2))
5150 H3.DEG = H3.RAD / DEG.TO.RAD
5160
5170 IF A3 = 1 THEN 5290
5180 REM ********************************************************************
5190 REM * SOLAR HEATING (Q3) AT EARTH SURFACE (W/M2) IN CLEAR AIR (P6)
5200 REM ********************************************************************
5210 Q3 = -42.2391 + 63.8044 * H3.DEG - 1.922 * H3.DEG ^ 2
5220 Q3 = Q3 + .034692 * H3.DEG ^ 3 - 3.6112E-04 * H3.DEG ^ 4
5230 Q3 = Q3 + 1.9432E-06 * H3.DEG ^ 5 - 4.0761E-09 * H3.DEG ^ 6
5240 B$ = "CLEAR"
5250 GOTO 5330
5260 REM ********************************************************************
5270 REM * SOLAR HEAT (Q3) AT EARTH SURFACE (W/M2) IN INDUSTRIAL AIR (P6)
5280 REM ********************************************************************
5290 Q3 = 53.1821 + 14.211 * H3.DEG + .66138 * H3.DEG ^ 2
5300 Q3 = Q3 - .031658 * H3.DEG ^ 3 + 5.4654E-04 * H3.DEG ^ 4
5310 Q3 = Q3 - 4.3446E-06 * H3.DEG ^ 5 + 1.3236E-08 * H3.DEG ^ 6
5320 B$ = "INDUSTRIAL"
5330 REM * CALCULATE SOLAR AZIMUTH VARIABLE, CHI
5335
5340 CHI.DENOM = SIN(CDR.LAT.RAD) * COS(HOUR.ANG.RAD) - COS(CDR.LAT.RAD) *
TAN(DECL.RAD)
5350 CHI = SIN(HOUR.ANG.RAD) / CHI.DENOM
5360 REM * CALCULATE SOLAR AZIMUTH CONSTANT, CAZ
5370 IF HOUR.ANG.DEG < 0 AND CHI >= 0 THEN
    CAZ = 0
5380 ELSEIF HOUR.ANG.DEG >= 0 AND CHI < 0 THEN
    CAZ = 360
5390 ELSE
    CAZ = 180
5495 END IF
5400 REM * CALCULATE SOLAR AZIMUTH IN DEGREES, Z4.DEG
5410 Z4.DEG = CAZ + ATN(CHI)
5420 Z4.RAD = Z4.DEG * DEG.TO.RAD
5510 Z1.RAD = Z1.DEG * DEG.TO.RAD
5520 E1 = COS(H3.RAD) * COS(Z4.RAD - Z1.RAD)
5530 E2.RAD = ATN(SQR(1 / E1 ^ 2 - 1))
5540 QS = ABSORP * Q3 * SIN(E2.RAD) * D / 1000 * (1 + .0001148 * CDR.ELEV -
1.108E-08 * CDR.ELEV ^ 2)
5542 IF QS < 0 THEN QS=0.0
5545
5550 GOTO 5570
5560 QS = 0!
5570 RETURN
8000 REM ////////////////////////////////
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```
8010 REM / SUBROUTINE TO ENTER INPUT DATA
8020 REM ////////////////////////////////
8030 REM NSELECT IS TYPE OF CALCULATION
8040 REM 1 = STEADY-STATE TEMP, 2 = STEADY-STATE RATING
8045 REM 3 = TRANSIENT TEMP, 4 TRANSIENT RATING
8150 REM *****************
8160 REM * TRANSIENT DATA
8170 REM *****************
8180 INPUT #1, IORTPRELOAD, Z$
8190 IF IORTPRELOAD = 1 THEN INPUT #1, XIPRELOAD, Z$
8200 IF IORTPRELOAD = 2 THEN INPUT #1, TCDRPRELOAD, Z$
8210 IF NSELECT = 4 THEN INPUT #1, TCDRMAX, Z$ ELSE TCDRMAX = 1000
8220 IF NSELECT = 3 THEN INPUT #1, XISTEP, Z$
8230 INPUT #1, SORM, Z$
8240 INPUT #1, TT, Z$
8250 INPUT #1, DELTIME, Z$
8260 IF SORM = 1 THEN TT = TT * 60
8270 REM **************
8280 REM * WEATHER DATA
8290 REM **************
8300 INPUT #1, TAMB, Z$
8310 INPUT #1, VWIND, Z$
8320 INPUT #1, WINDANG.DEG, Z$
8340 REM *****************
8350 REM * CONDUCTOR DATA
8360 REM *****************
8370 INPUT #1, C$, Z$
8380 INPUT #1, D, Z$
8390 INPUT #1, TLO, THI, Z$
8400 INPUT #1, RLO, RHI, Z$
8430 RLO = RLO / 1000
8440 RHI = RHI / 1000
8450 IF NSELECT = 1 OR NSELECT = 2 THEN 8510
8460 INPUT #1, HNH, Z$
8470 IF HNH = 1 THEN INPUT #1, HEATOUT, Z$: HEATCORE = 0
8480 IF HNH = 2 THEN INPUT #1, HEATOUT, HEATCORE, Z$
8490 REM
8500 REM
8510 HEATCAP = HEATOUT + HEATCORE
8520 INPUT #1, EMISS, ABSORP, Z$
8530 INPUT #1, CDR.ELEV, Z$
8540 INPUT #1, Z1.DEG, Z$
8550 REM
8560 REM **********************
8570 REM * SOLAR HEATING DATA
8580 REM **********************
8585 REM SPECIFY LATITUDE AND SUN TIME
8590 INPUT #1, CDR.LAT.DEG, Z$
8600 INPUT #1, SUN.TIME, NDAY, Z$
8610 INPUT #1, A3, B$, Z$
8620 RETURN
9000 REM
//////////////////////////////////////////////////////////////////////////
9010 REM / SUBROUTINE TO CALCULATE THERM COEF OF RAC & HEATCAP & WIND
CORRECTION
9020 REM
//////////////////////////////////////////////////////////////////////////
9030 REM ************************************************************
9040 REM * SETUP LINEAR CONDUCTOR RESISTANCE EQ AS FUNCTION OF TEMP
9042 REM * B IN OHM/M-C AND B1 IN OHM/M
9050 REM ************************************************************
9060 B = (RHI - RLO) / (THI - TLO)
9070 B1 = RLO - B * TLO
```

```
9080 REM ******************************************************
9090 REM * SET UP LINEAR HEAT CAPACITY EQS AS FUNCTION OF TEMP
9100 REM ******************************************************
9110 REM ******************************************************
9120 REM * CORRECTION FACTOR (YC) FOR NON-PERPENDICULAR WIND
9130 REM ******************************************************
9140 WINDANG.RAD = 1.570796 - WINDANG.DEG * PIANG
9150 YC = 1.194 - SIN(WINDANG.RAD) - .194 * COS(2! * WINDANG.RAD) + .368 *
SIN(2! * WINDANG.RAD)
9160 RETURN
10000 REM ////////////////////////////////////////////////////////////////
10010 REM / SUBROUTINE TO CALCULATE STARTING VALUE FOR CURRENT ITERATION
10020 REM / BY ASSUMING ADIABATIC HEATING DURING TIME TT
10030 REM ////////////////////////////////////////////////////////////////
10040 TCDR = (TCDRMAX + TAMB) / 2
10050 IF TT < 60 THEN HEATCAP = HEATOUT ELSE HEATCAP = HEATOUT + HEATCORE
10060 GOSUB 15000
10070 AT = SQR(HEATCAP * (TCDRMAX - TAMB) / TT) / W4
10080 TCDR = TCDRPRELOAD
10090 NFLAG = 1
10100 GOSUB 13000
10110 RETURN
11000 REM ////////////////////////////////////////////////////////////
11010 REM / SUBROUTINE CALCS CDR TEMP VS TIME FOR STEP CHANGE CURRENT
11020 REM ////////////////////////////////////////////////////////////
11030 IF NSELECT = 4 THEN PRINT USING "TRYING A CURRENT OF ########.#### AMPS";
XISTEP
11040 FLAG = 0
11050 ATCDR(1) = TCDRPRELOAD
11060 TCDR = ATCDR(1)
11070 GOSUB 15000
11080 K = 1
11090 ATCDR(K + 1) = TCDR + (W4 ^ 2 * XISTEP ^ 2 + QS - QR - QC) * DELTIME /
HEATCAP
11100 TIME(K + 1) = TIME(K) + DELTIME
11110 TCDR = ATCDR(K + 1)
11115 IF NSELECT = 4 GOTO 11130
11120 PRINT "TIME = "; TIME(K + 1); " SECONDS / "; "CDR TEMP = "; TCDR; "DEG C"
11130 IF NSELECT = 3 AND TCDR > TCDRMAX THEN 11280
11140 REM ************************************************************************
11150 REM *
11160 REM ************************************************************************
11170 GOSUB 15000
11180 K = K + 1
11190 IF K = 3000 THEN PRINT "TIME INTERVAL TOO SMALL. ARRAY OUT OF BOUNDS ":
GOTO 1880
11200 IF TIME(K) < TT THEN 11090
11210 IF XISTEP = 0 AND TCDR > TCDRMAX THEN 11220 ELSE 11250
11220 PRINT "EVEN IF THE CURRENT IS REDUCED TO ZERO AMPS, THE CONDUCTOR"
11230 PRINT USING "TEMPERATURE WILL NOT DECREASE TO ####.# DEG C IN ####.#
MINUTES"; TCDRMAX; TT / 60
11240 GOTO 1880
11250 REM *********************************
11260 REM * CHECK FOR SHORT DURATION FAULTS
11270 REM *********************************
11280 IF TIME(K) >= 60 OR FLAG = 1 OR HEATCORE = 0 OR TT < 60 THEN GOTO 11320
11290 HEATCAP = HEATOUT
11300 FLAG = 1
11310 GOTO 11050
11320 KTIMEMAX = K
11330 RETURN
12000 REM ////////////////////////////////////////////////////
12010 REM / SUBROUTINE ITERATES TO FIND CONDUCTOR TEMPERATURE
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```
12020 REM / GIVEN THE CONDUCTOR CURRENT
12030 REM ////////////////////////////////////////////////
12040 IF NFLAG = 0 THEN TCDR = X: GOSUB 15000: TEMP = XIDUMMY - TR: RETURN
12050 IF NFLAG = 1 THEN XISTEP = X: GOSUB 11000
12060 IF TCDRPRELOAD <= TCDRMAX THEN TEMP = TCDRMAX - TCDR: RETURN
12070 IF TCDRPRELOAD > TCDRMAX THEN TEMP = TCDR - TCDRMAX: RETURN
13000 REM ////////////////////////////////////////////////////////////////////
13010 REM / SUBROUTINE RTMI MUELLER-S ITERATION METHOD SELECTS A CURRENT  /
13020 REM / WHICH JUST RAISES TCDR TO TCDMAX IN THE TIME TT. THIS CURRENT /
13030 REM / IS THE TRANSIENT RATING OF THE CONDUCTOR. IT DOES THIS BY   /
13040 REM / REPEATEDLY GUESSING A CURRENT - XISTEP - CALCULATING TCDR AT TT /
13050 REM / AND COMPARING THE CALCULATED TCDR TO TCDRMAX. ROUTINE SUPPLIED /
13060 REM / COURTESY OF BILL HOWINGTON.                              /
13070 REM ////////////////////////////////////////////////////////////////////
13080 REM * START BY PREPARING TO ITERATE
13090 REM *******************************
13100 XLI = 0: XRI = 0: EPS = .049: IEND = 20: X = 0
13110 GOSUB 14000
13120 IER = 0: XL = XLI: XR = XRI: X = XL: TOL = X
13130 GOSUB 12000
13140 F = TEMP: IF XLI = XRI OR F = 0 THEN 13530
13150 FL = F: X = XR: TOL = X
13160 GOSUB 12000
13170 F = TEMP: IF F = 0 THEN 13530
13180 FR = F: IF (SGN(FL) + SGN(FR)) = 0 THEN 13200 ELSE 13760
13190 REM ************************************************
13200 REM BASIC ASSUMPTION FL*FR LESS THAN 0 IS SATISFIED.
13210 REM ************************************************
13220 I = 0
13230 REM ********************
13240 REM START ITERATION LOOP
13250 REM ********************
13260 I = I + 1
13270 REM ********************
13280 REM START BISECTION LOOP
13290 REM ********************
13300 FOR JK = 1 TO IEND
13310 X = .5 * (XL + XR): TOL = X: GOSUB 12000
13320 F = TEMP: IF F = 0 THEN 13530
13330 IF (SGN(F) + SGN(FR)) = 0 THEN 13370 ELSE 13380
13340 REM ************************************************************
13350 REM INTERCHANGE XL AND XR IN ORDER TO GET THE SAME SIGN IN F AND FR
13360 REM ************************************************************
13370 TOL = XL: XL = XR: XR = TOL: TOL = FL: FL = FR: FR = TOL
13380 TOL = F - FL: DA = F * TOL: DA = DA + DA
13390 IF (DA - FR * (FR - FL)) >= 0 THEN 13410
13400 IF (I - IEND) <= 0 THEN 13570
13410 XR = X: FR = F
13420 REM ********************************************
13430 REM TEST ON SATISFACTORY ACCURACY IN BISECTION LOOP
13440 REM ********************************************
13450 TOL = EPS
13460 IF (ABS(FR - FL) - TOL) <= 0 THEN 13530
13470 NEXT JK
13480 REM ************************************************************
13490 REM END OF BISECTION LOOP - NO CONVERGENCE AFTER IEND ITERATION STEPS
13500 REM FOLLOWED BY IEND SUCCESSIVE STEPS OF BISECTION
13510 REM ************************************************************
13520 IER = 1: GOTO 13780
13530 RETURN
13540 REM ************************************************************
13550 REM COMPUTATION OF ITERATED X-VALUE BY INVERSE PARABOLIC INTERPOLATION
13560 REM ************************************************************
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```
13570 DA = FR - F: DX = (X - XL) * FL * (1 + F * (DA - TOL) / (DA * (FR - FL)))
/ TOL
13580 XM = X: FM = F: X = XL - DX: TOL = X
13590 GOSUB 12000
13600 F = TEMP: IF F = 0 THEN 13530
13610 REM ********************************************
13620 REM TEST ON SATISFACTORY ACCURACY IN ITERATION LOOP
13630 REM ********************************************
13640 TOL = EPS
13650 IF (ABS(F) - TOL) <= 0 THEN 13530
13660 REM **********************************
13670 REM PREPARATION OF NEXT BISECTION LOOP
13680 REM **********************************
13690 IF (SGN(F) + SGN(FL)) <> 0 THEN 13710
13700 XR = X: FR = F: GOTO 13260
13710 XL = X: FL = F: XR = XM: FR = FM: GOTO 13260
13720 REM ************************************
13730 REM END OF ITERATION LOOP
13740 REM ERROR RETURN IN CASE OF WRONG INPUT DATA
13750 REM ************************************
13760 IF XHI <> XLO THEN 13770 ELSE RETURN
13770 IER = 2: JK = 0
13780 BEEP: PRINT "NUMBER OF ITERATIONS= "; JK
13790 PRINT "ITERATION ROUTINE CONDITION CODE,IER= "; IER
13800 IF IER = 2 THEN PRINT "TCDR OUT OF TEMPERATURE RANGE"
13810 IF IER = 1 THEN PRINT "NO CONVERGENCE IN SUBROUTINE TRANS"
13820 STOP
14000 REM ////////////////////////////////////////////////////////////
14010 REM / SUBROUTINE GUESS TO DETERMINE INITIAL BOUNDS FOR ITERATION
14020 REM ////////////////////////////////////////////////////////////
14030 IF NFLAG = 0 THEN XLO = TAMB: XHI = 1000: DIV = 10
14040 IF NFLAG = 1 THEN XLO = 0: XHI = 10 * AT: DIV = 10
14050 CHA = (XHI - XLO) / DIV: NUM = INT(DIV): X = XLO
14060 GOSUB 12000
14070 FO = TEMP
14080 FOR JK = 1 TO NUM
14090 X = XLO + JK * CHA: GOSUB 12000
14100 FF = TEMP: IF (SGN(FF) + SGN(FO)) = 0 THEN 14140
14110 FO = FF
14120 NEXT JK
14130 XLI = XLO: XRI = XHI: RETURN
14140 XRI = X: XLI = X - CHA: RETURN
15000 REM ////////////////////////////////////////////////////////////////
15010 REM / SUBROUTINE TO CALCULATE THERMAL RATING GIVEN A CDR TEMP (TCDR),
15020 REM / AND CONDUCTOR PARAMETERS AND WEATHER CONDITIONS
15030 REM ////////////////////////////////////////////////////////////////
15040 REM PRINT USING "TRYING A TCDR OF ####.### DEG C"; TCDR
15050 REM ********************************************************
15060 REM * CALC CONDUCTOR HEAT LOSS (QR) BY RADIATION (WATTS/M)
15070 REM ********************************************************
15080 T3 = TCDR + 273
15090 T4 = TAMB + 273
15102 QR = .0178 * EMISS * D * ((T3 / 100) ^ 4 - (T4 / 100) ^ 4)
15110 REM ************************************************************
15120 REM * CALC CONDUCTOR HEAT LOSS BY CONVECTION (WATTS/M)
15125 REM * NOTE CONVECTION EQUATIONS FORM IS DIFFERENT THAN IN BODY OF 738
15128 REM * BUT THE RESULTS OF CALCULATION ARE THE SAME
15130 REM ************************************************************
15140 T5 = (TCDR + TAMB) / 2
15160 U1 = 1.458E-06 * (T5 + 273) ^ 1.5 / (T5 + 383.4)
15172 P1 = (1.2932 - .0001525 * CDR.ELEV + 6.379E-09 * CDR.ELEV ^ 2) / (1 +
.00367 * T5)
15180 K1 = .02424 + 7.477E-05 * T5 - 4.407E-09 * T5 ^ 2
```

```
   IF DEBUG = 0 THEN PRINT #2, "U1,P1,K1 = "; U1, P1, K1
15182 REM ************************************************************
15184 REM * CALC CONDUCTOR HEAT LOSS (QC) BY NATURAL CONVECTION (WATTS/M)
15186 REM ************************************************************
15188 IF (TCDR - TAMB) < 0! THEN TCDR = TAMB + .1
15191 QC = .0205 * P1 ^ .5 * D ^ .75 * (TCDR - TAMB) ^ 1.25
15192 IF VWIND = 0 THEN 15450
15194 REM ************************************************************
15196 REM * CALC CONDUCTOR HEAT LOSS (QCF) BY FORCED CONVECTION (WATTS/M)
15198 REM ************************************************************
15202 Z = D * P1 * VWIND / U1
15212 Q1 = .0119 * Z ^ .6 * K1 * (TCDR - TAMB)
15222 Q2 = (1.01 + .0372 * Z ^ .52) * K1 * (TCDR - TAMB)
15230 IF Q1 - Q2 <= 0 THEN 15260
15240 QCF = Q1
15250 GOTO 15270
15260 QCF = Q2
15265
15270 QCF = QCF * YC
15370 REM ************************************************************
15380 REM * SELECT LARGER OF CONVECTIVE HEAT LOSSES (QC VERSUS QCF)
15390 REM ************************************************************
15400 IF QCF < QC THEN 15450
15410 QC = QCF
15420 REM ***************************************
15430 REM * CALC SUM OF STEADY STATE HEAT FLOWS
15440 REM ***************************************
15450 R5 = -QS + QC + QR
15460 REM ************************************************
15470 REM * CALC SQRT OF CONDUCTOR RESISTANCE IN OHMS/M
15480 REM ************************************************
15492 W4 = SQR(B1 + B * TCDR)
15500 IF R5 <= 0 THEN TR = 0: GOTO 15560
15510 R4 = R5 ^ .5
15520 REM ************************************************
15530 REM * CALCULATE THERMAL RATING (AMPACITY) IN AMPERES
15540 REM ************************************************
15550 TR = R4 / W4
15560 RETURN
20000 REM ////////////////////
20010 REM / COMMENTS ON PROGRAM
20020 REM ////////////////////
20030 REM *
20040 REM * THE PROGRAM DOES NOT CALCULATE ANY INTERNAL RADIAL OR AXIAL
20050 REM * TEMPERATURE GRADIENTS. THIS IS NORMALLY NOT A SOURCE OF
20060 REM * SIGNIFICANT ERROR EXCEPT FOR INTERNALLY COMPLEX CONDUCTORS
20070 REM * SUCH AS FIBER-OPTIC SHIELD WIRE AND FOR NON-HOMOGENEOUS CONDUCTORS
20080 REM * FOR FAULT CURRENTS OF LESS THAN 1 MINUTE. THE PROGRAM DOES NOT
20090 REM * APPLY TO INTERNALLY COMPLEX CONDUCTORS, IT DOES CALCULATE A WORST
20100 REM * CASE ESTIMATE OF TEMPERATURE/RATING FOR ACSR OR ACSR/AW BY
NEGLECTING
20110 REM * THE HEAT STORAGE CAPACITY OF THE RELATIVELY POORLY CONDUCTING CORE
20120 REM * FOR STEP CURRENTS WHICH PERSIST FOR LESS THAN ONE MINUTE.
20130 REM * THE VARIATION IN SPECIFIC HEAT WITH TEMPERATURE IS NEGLECTED.
20140 REM * ADDED COMMENTS 7/97 DAD
20150 REM * ADDED SI FORMULAS, SOLAR EQUATIONS, AND CHANGED AIR PARAMETERS
```